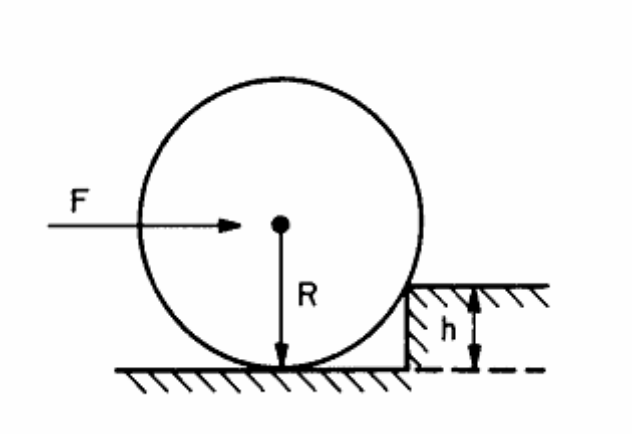
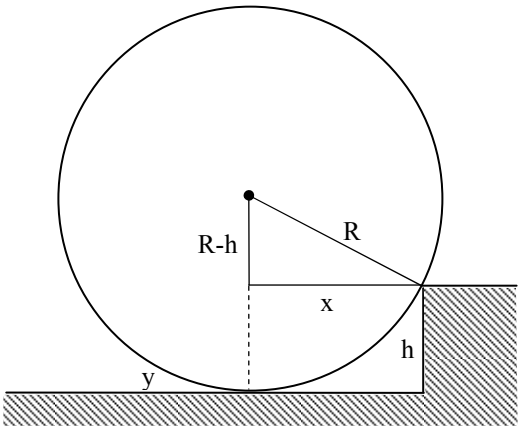
wheel and block



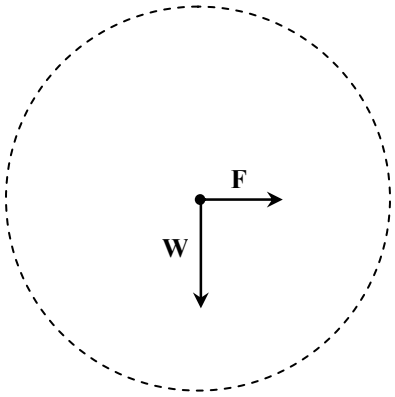
What horizontal force F (applied at the axle) is required to push a wheel of weight W and radius R over a block of height h?

Michael A. Gottlieb's Solution (using virtual work)

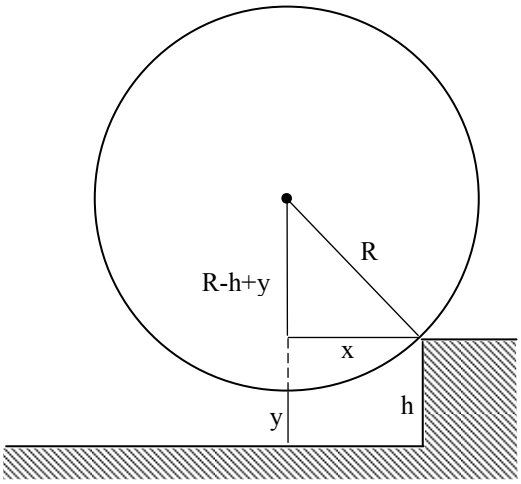


Initial position (y=0)

$x = \sqrt{(2R-h)h}$



Forces



General position

$x = \sqrt{R^2-(R-h+y)^2}$

By the principle of virtual work, $F\,dx = W\,dy$, or $F = W\Big/\dfrac{dx}{dy}$. From the general position, $\dfrac{dx}{dy} = -\dfrac{R-h+y}{x}$. Therefore $|F| = W\dfrac{x}{R-h+y}$. In the initial position y=0, and $x = \sqrt{(2R-h)h}$, thus the required force is $|F| = W\dfrac{\sqrt{(2R-h)h}}{R-h}$.